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The Pauropoda and Symphyla of the Geneva Museum VII. Scanning electron microscope studies in *Gravieripus cordatus* Scheller (Myriapoda, Pauropoda, Eurypauropodidae)

by

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With 24 figures

ABSTRACT

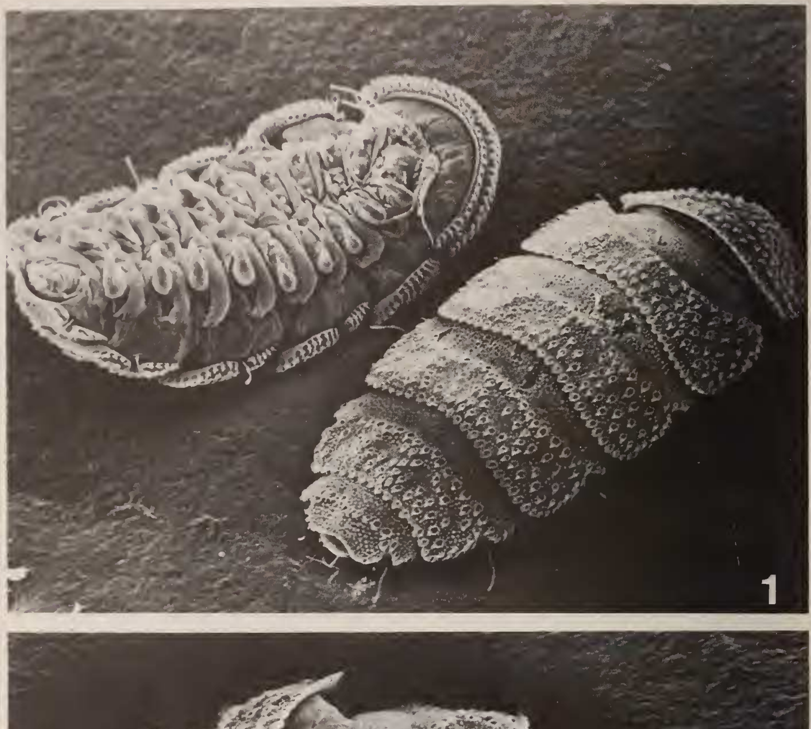
Some surface structures in the Eurypauropodidae species *Gravieripus cordatus* Scheller are described. Disregarding the diverse structures of the strongly sclerotized tergites they seem to show great resemblances to corresponding structures in the family Pauropodidae.

INTRODUCTION

The study of the submicroscopic structure of the Pauropoda has long been neglected. As to those cuticular details which are of particular interest to the taxonomist they are almost completely lacking. However the attention devoted to the group by MASSOUD (1969*a*, *b*, 1970) has revealed unknown structures in the antennal flagella, the globulus and the apical organ of the tarsi. Some information about the cuticle of the trunk and the temporal organs is also found in HAUPT's studies (1972, 1973, 1976). Both authors studied species of the family Pauropodidae.

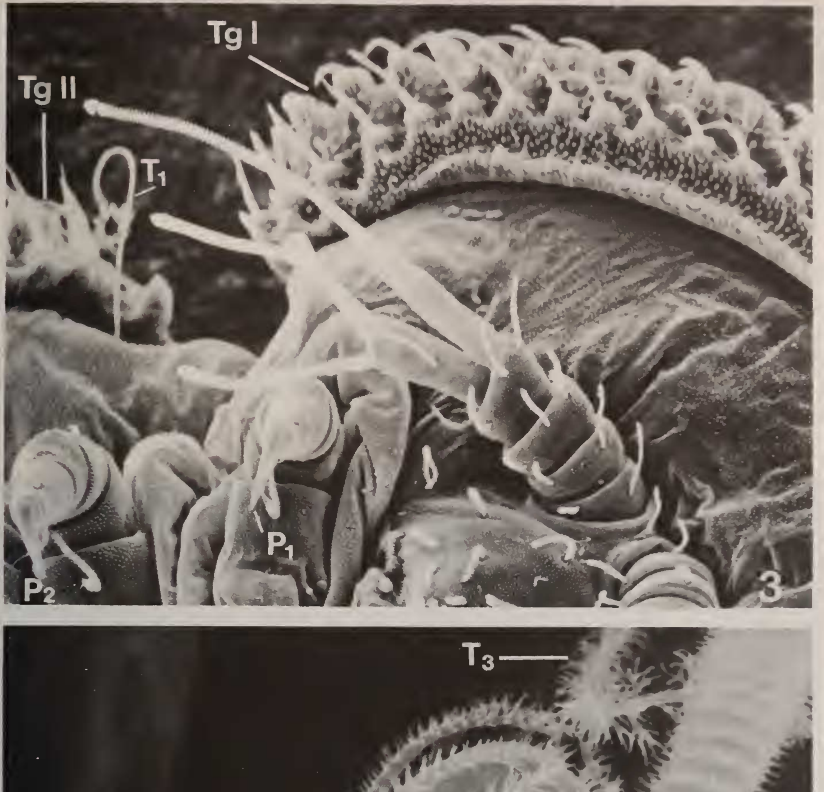
MATERIAL

Recently one of us (Dallai) has found representants in Italy of *Gravieripus cordatus* (Figs. 1-2), a Eurypauropodidae species described in 1974 by the second of us (Scheller) on material from Spain and Turkey.



FIGS. 1-2.

Gravieripus cordatus: 1. Upper left, ventral view (♀); lower right, dorsal view. Note the different kind of sculpture on the anterior and posterior part of tergites. × 100. — 2. Dorsal side. Anterior part of body (left) expanded, bent down. The intersegmental surface seems smooth at this enlargement. × 150.



Figs. 3-4.

Gravieripus cordatus: 3. Anterior margin of the first tergite (Tg I), right side, ventral view. Note the series of spines along the edge and the antennal organization. Tg II, second tergite, with trichobothrium T_1; P_1 and P_2 first and second pairs of legs. × 500. — 4. Antennal globulus and parts of two flagella. The bent structure above the globulus is part of trichobothrium T_3. × 5000.

The Italian material was collected at Montalbuccio, near Siena, in November, 1974. Five specimens are in the Geneva Museum: 3 ad. (♀), 1 subad. (♀), 1 juv. with 6 pairs of legs.

In Eurypauropodidae the tergites are strongly chitinized and their cuticle is ornamented and provided with tubercles and bristle-, spine- or leaf-shaped setae. Many of these structures and others too were too small to be interpreted with the light microscope (Wild M 20, oil immersion, phase contrast) used in preparing the original description. A close up study has now been made at the Istituto di Zoologia, Siena

METHODS

All the material used for this investigation was prepared according to the critical point drying method. Living specimens were previously fixed in alcohol 70% for 15′ and then dehydrated in a graded series of ethanol. Freon 113 was used as intermediate

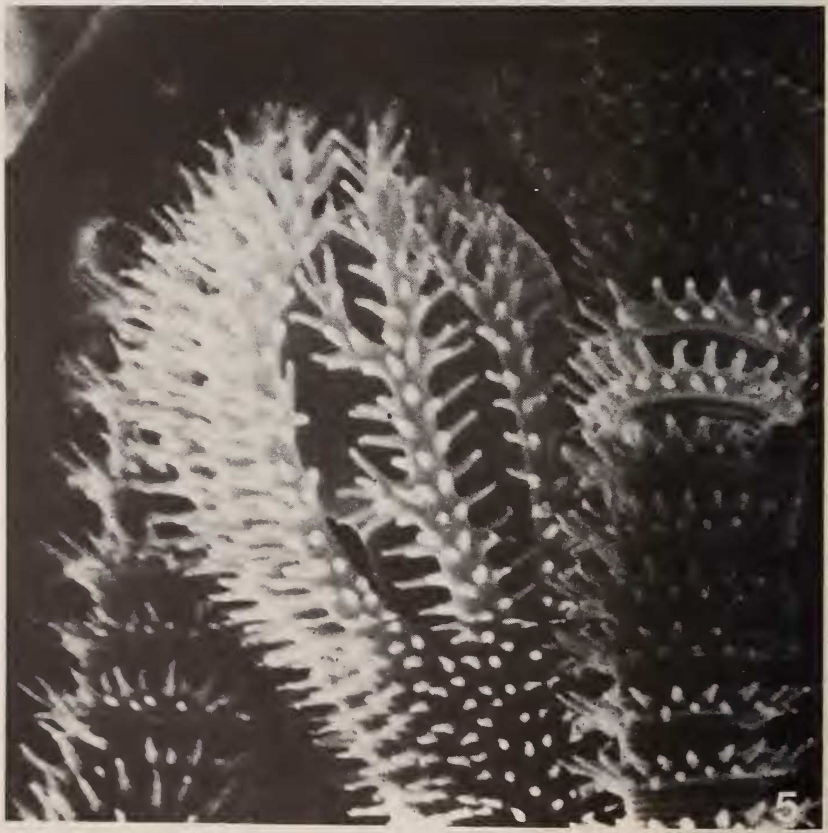


FIG. 5.

Gravieripus cordatus: Antennal globulus and parts of two flagella. Between the discs of the flagellum the surface of the central tube shows transverse ridges. × 7000.

fluid. Before proceeding to the critical point drying method, the material was put in a small basket with very small meshes and then rapidly transferred in a Bomar Apparatus SPC-900. Carbon dioxide was used as transitional fluid. The specimens were then placed on mounting basis and coated with a gold film in a Balzer Sputtering Device. They were examined with the Scanning electron microscope JSM-2 and the Coated and Welth Field Emission electron microscope.

Antennae

The ultrastructure of the antennae in two Pauropodidae species, *Allopauropus vulgaris* (Hansen) and *Stylopauropus pedunculatus* (Lubbock), was described by MASSOUD (1969*a*, *b*). Disregarding differences in size and proportions these organs are very alike in *Gravieripus cordatus* (Fig. 3). In both families all parts are densely pubescent. In our species the long-stalked globulus is distally dividing into a pro-

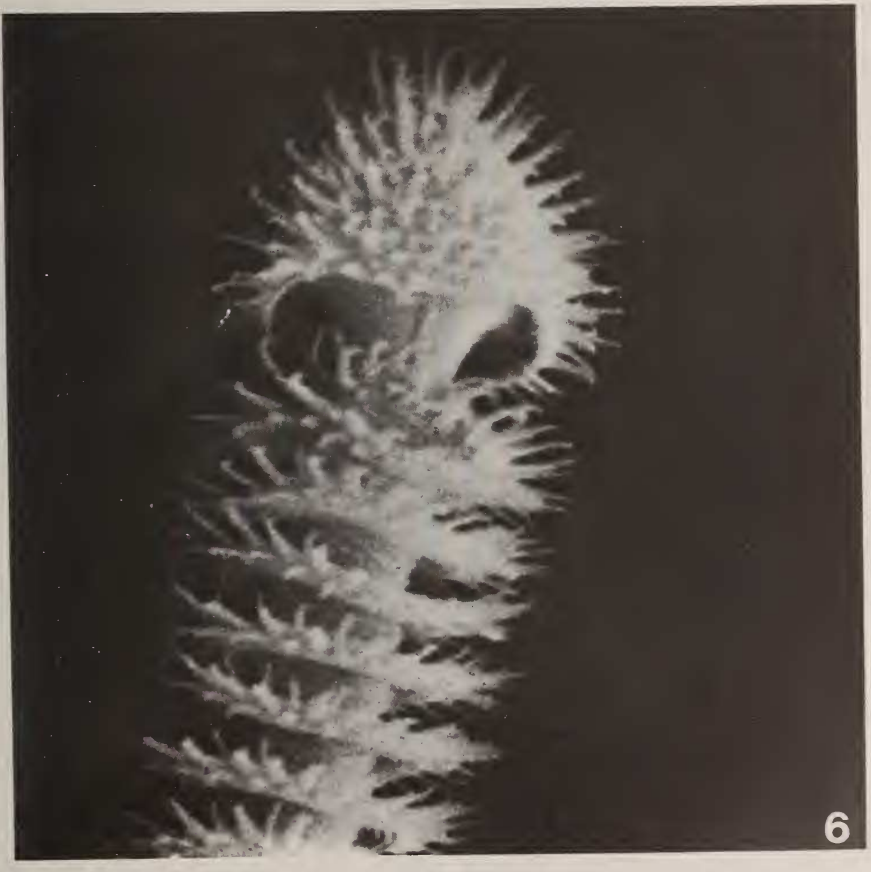


FIG. 6.

Gravieripus cordatus: Distal part of antennal flagellum.
The surface of the central tube between two discs has oblique ridges. × 12 000.

portionately low number of bracts (Fig. 4) which are tapering distally, partly forked deeply down and partly having isolated short branches (Fig. 5). The former ramification was earlier known in a few Pauropodidae species (e.g. *Allopauropus foliaceus* Scheller and *A. insularis* Scheller), the latter not. The pubescence hairs of the globulus are almost straight but in the species studied by MASSOUD distinctly curved.

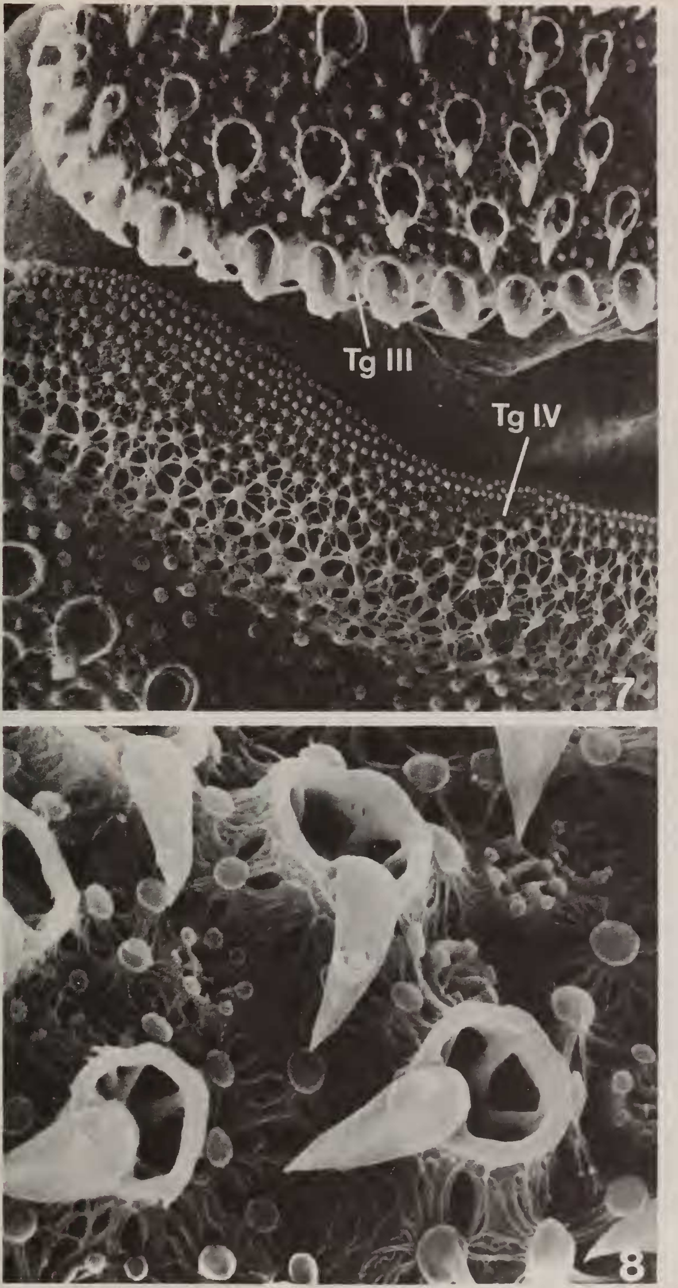
The flagella are of similar shape in both families disregarding the bases which are not cylindrical but proportionately long and tapering distally in Eurypauropodidae. The distal swelling of the central tube generally occurring in Pauropodidae has not been proved but the apical cones do not deviate. The secondary subapical rudimentary cone also often in Pauropodidae seems to lack (Fig. 6). Between the base segment and the apical cone the flagellum consists of discs perpendicular to the central tube and interposed by cylindrical portions of it. The discs are surrounded by circlets of short hairs. In the Pauropodidae species mentioned there were two or three circlets, in *G. cordatus* there are two. The shape of the hairs seem to vary from species to species because they are digitiform in *S. pedunculatus* and hook-like in *A. fagei* (MASSOUD 1969). Here the two circlets are unequal. The hairs of the distal circlets are longest, with ends bent upwards, in the outer part of the flagella hook-like (Fig. 6). Those of the proximal circlets are shorter and with distal ends bent downwards. The latter hairs are inserted below the interspace of the hairs of the distal circlets (Fig. 5). Between the discs the surface of the central tube have some transverse ridges which are running parallel with the discs proximally, but obliquely in the distal part of the flagellum.

Tergites

In the light microscope the tergite surface between the setae is strongly coarse (SCHELLER 1974: 620, figs. 2*a*, *c*, *d*). There it seems to consist of a very thin transparent membrane with numerous small circular perforations into which short conical tubercles are projecting from below and pushing it up. Each tubercle seems to have vertical ridges radiating in many directions. Between the tubercles a few small rounded spots with irregular upper surface could be seen. In the SEM-photos the conical tubercles have flattened cushion-like tips with a subapical constriction (Figs. 7-9). They show variable size, are usually smaller on the anterior part of each tergite and are connected with the neighbouring ones by laminar expansions (Fig. 9) which form a more or less compact network (Fig. 7).

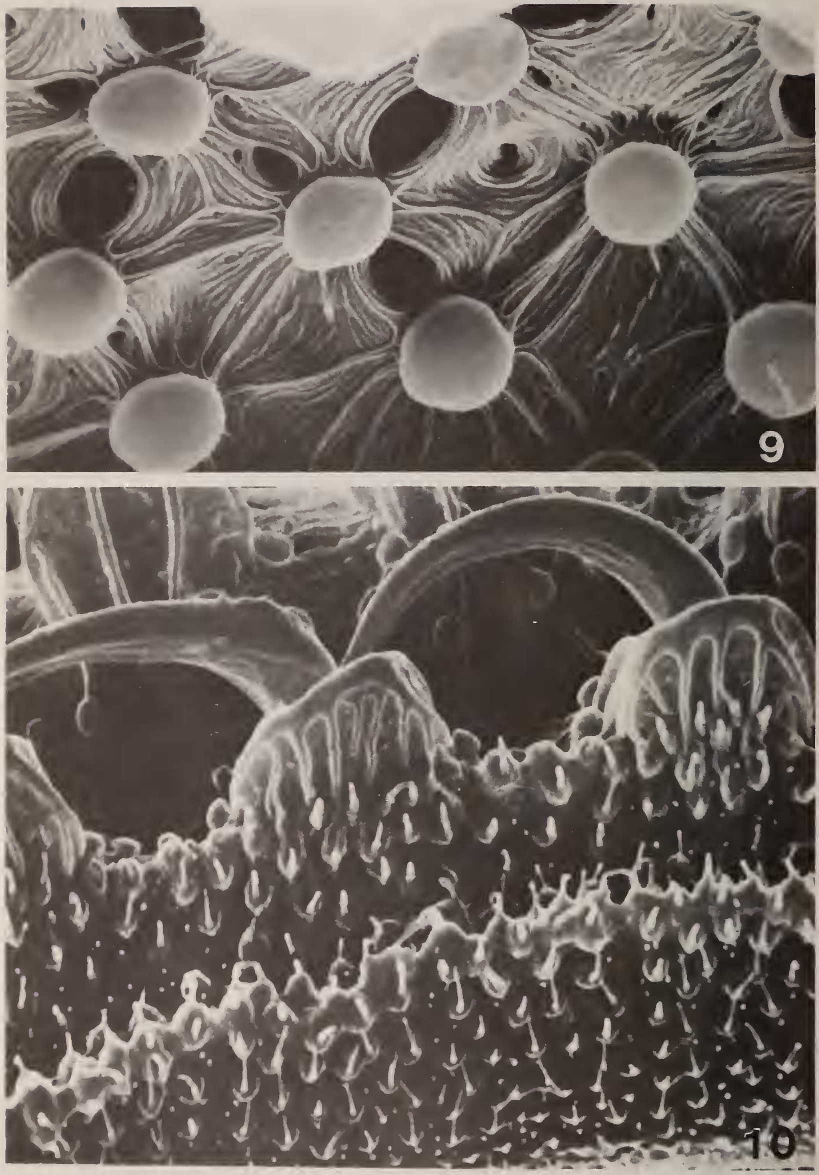
Among the tubercles there are other cuticular formations, which were seen in the light microscope as rounded coarse spots. They consist of circlets of 5-7 low cylindrical vertical projections joined together with thin lamellae forming vertical pores between them (Fig. 8). It is reasonable to suggest that such a cuticle represents a good system to resist mechanical strain without increasing too much the weight of the body; further it might protect against evaporation. The most elaborate cuticular structures, e.g. spines and conical tubules, are abundant on the posterior part of each tergite whereas the intersegmental surface is covered with thin and poorly structured cuticle.

The tooth-like setae in Figs. 7 and 8 are evenly spaced on tergite I and the posterior two thirds of the following tergites. They project from the bottom of a cuticular cage consisting of an upper circular or ovoid thickening supported by vertical props (Fig. 8). The tooth-like part of these structures are the axes of winged spines. The thin triangular wings seem less expanded when observed with the SEM, probably because their edges are bent down. The setae of the posteromarginal row were depicted by SCHELLER (1974: 620, Fig. 2a) as shields adorned with posteromedian sickleshaped spines. More likely they are of the same construction as the winged spines but with rudimentary wings.



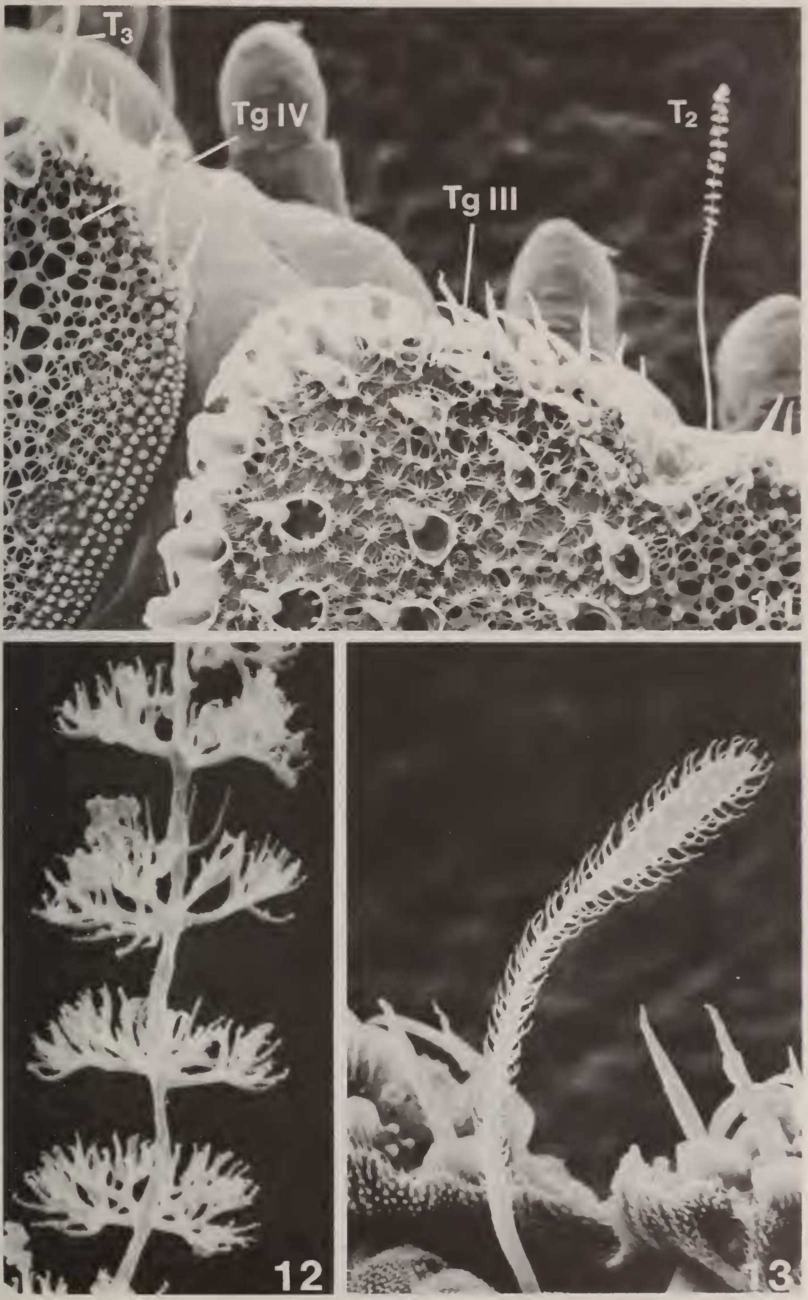
Figs. 7-8.

Gravieripus cordatus : 7. Left part of tergite III and anterior part of tergite IV. × 600. — 8. Spines and cuticle surface of tergite I. Conical tubules with cushion-like tips and circlets of 5-7 cylindrical structures are visible. × 2500.



FIGS. 9-10.

Gravieripus cordatus : 9. Anterior part of tergite I showing connections between conical structures. × 4500. — 10. Hook-like spines on lateral margin of a tergite. × 3500.



FIGS. 11-13.

Gravieripus cordatus : 11. Left posterolateral part of tergite III with trichobothrium T_2 and proximal part of tergite IV with trichobothrium T_2. × 500. — 12. Subapical part of trichobothrium T_2. × 10 000. — 13. Lateral part of tergite IV with trichobothrium T_3. × 1500.

The shields of the mentioned drawing have to be interpreted as circular deepenings from the bottom of which the hook-like spines are projecting.

The spines of the anterior margin of tergite I and the lateral margins of the following tergites are simple hook-like (Fig. 10) or straight pointed (Figs. 11 and 13). Intersegmental as well as ventral surfaces are homogeneously pubescent (Figs. 7, 17, 19, 22).

Trichobothria

All the trichobothria have simple axes. In the first two pairs, T_1 and T_2, they are very thin with a delicate, short, dense and erect pubescence of simple hairs on the proximal half (Fig. 11). In the middle the pubescence is growing much longer and its hairs become repeatedly ramose and arranged in well separated whorls (Fig. 12). The followings pairs, T_3-T_5, have thicker axes and simple pubescence hairs. The latter are oblique, curved upwards and with a distal S-shaped flexure (Fig. 14).

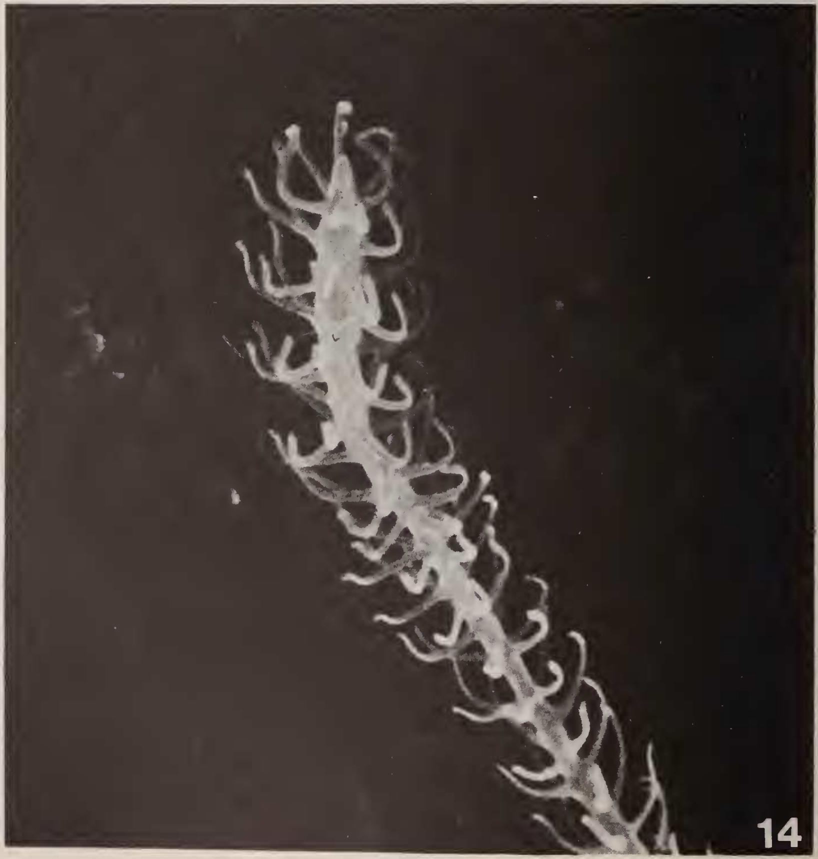
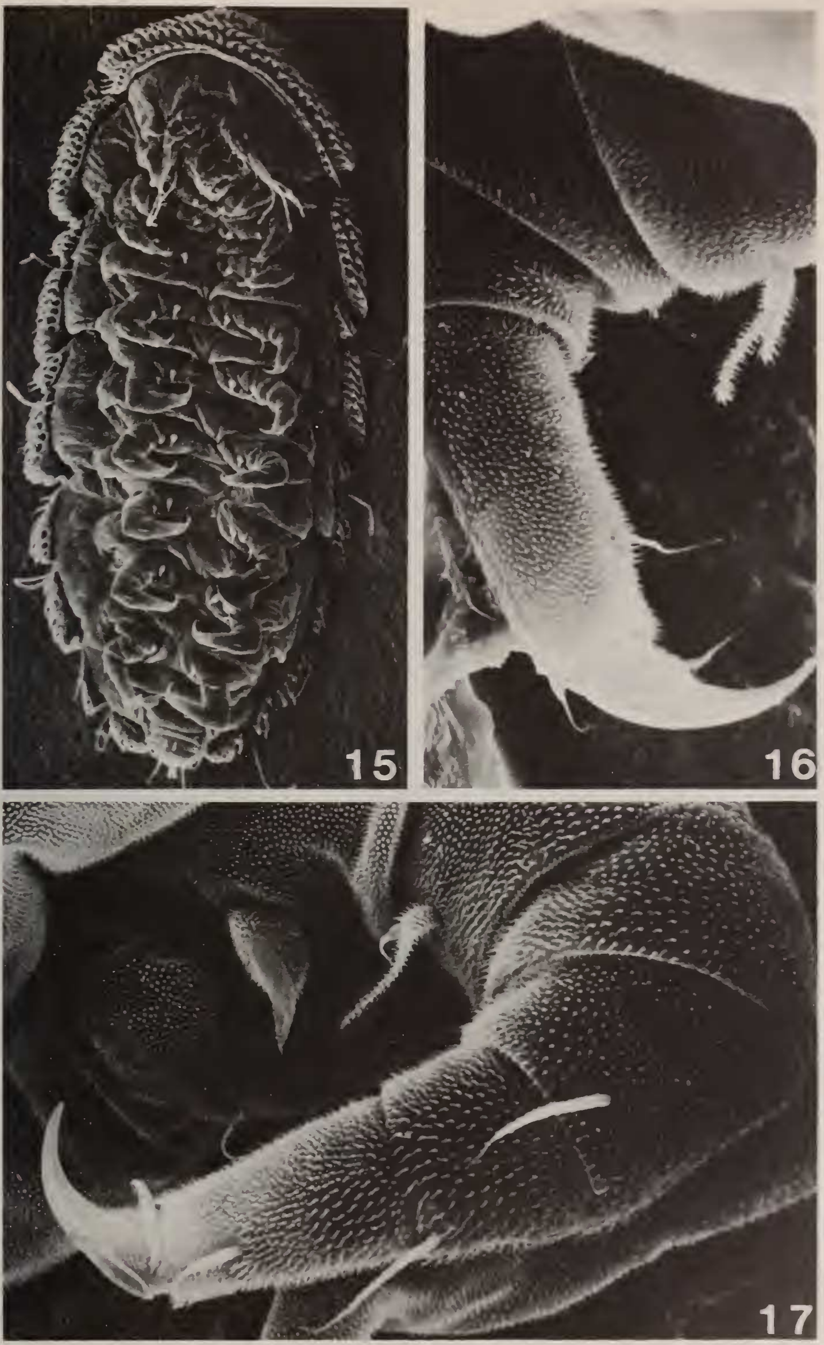


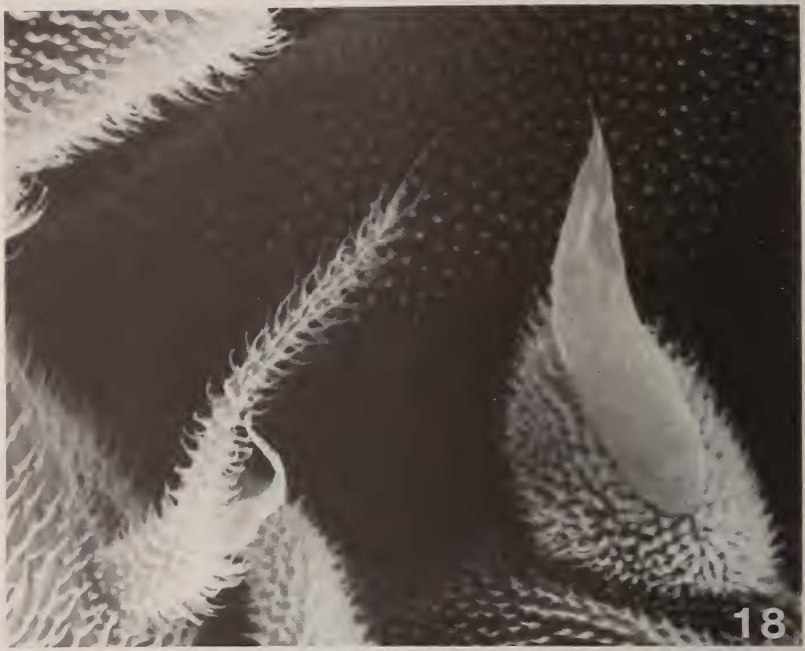
FIG. 14.

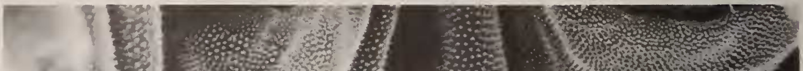
Gravieripus cordatus: Distal end of trichobothrium T_4. × 3500.



FIGS. 15-17.

Gravieripus cordatus : 15. Ventral view of adult ♀ showing head with antennae and the 9 pairs of legs. × 150. — 16. Posterior view of the 9th leg. × 1500. — 17. Anterior view of the 8th leg. × 1500.





FIGS. 18-19.

Gravieripus cordatus: 18 Details of setae on trochanter (left) and coxa of 8th leg. × 4500. — 19. Ventral side between legs 1 and 3. Female genital aperture and three coxal setae are visible. × 1500.

Legs

There are three genera of the family Eurypauropodidae in Europe: *Eurypauropus*, *Trachypauropus* and *Gravieripus*. The two former have been separated from the latter in having first and last pair of legs 5-segmented and intervening pairs 6-segmented while all the legs are 5-segmented in the latter. Theoretically this is a good character but sometimes it is not very useful in practical work. In *G. cordatus* the tarsi of the legs 2-8 have each around the segment a short whorl free from pubescence just below the proximal seta and a vestige of such a whorl might be found also in leg 9 (Fig. 16). In fig. 17 showing leg 8 the whorl looks like a real joint but it is much more indistinct in wet specimens and it seems never to be a functioning joint because not the slightest bend has been found there in any specimens.

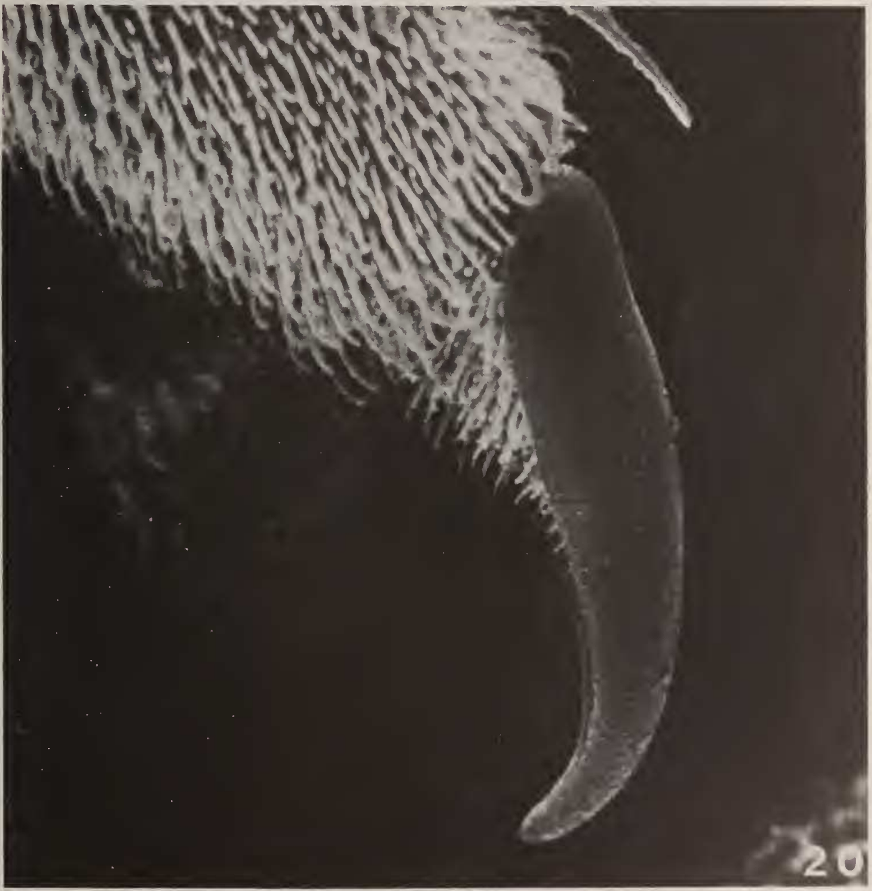
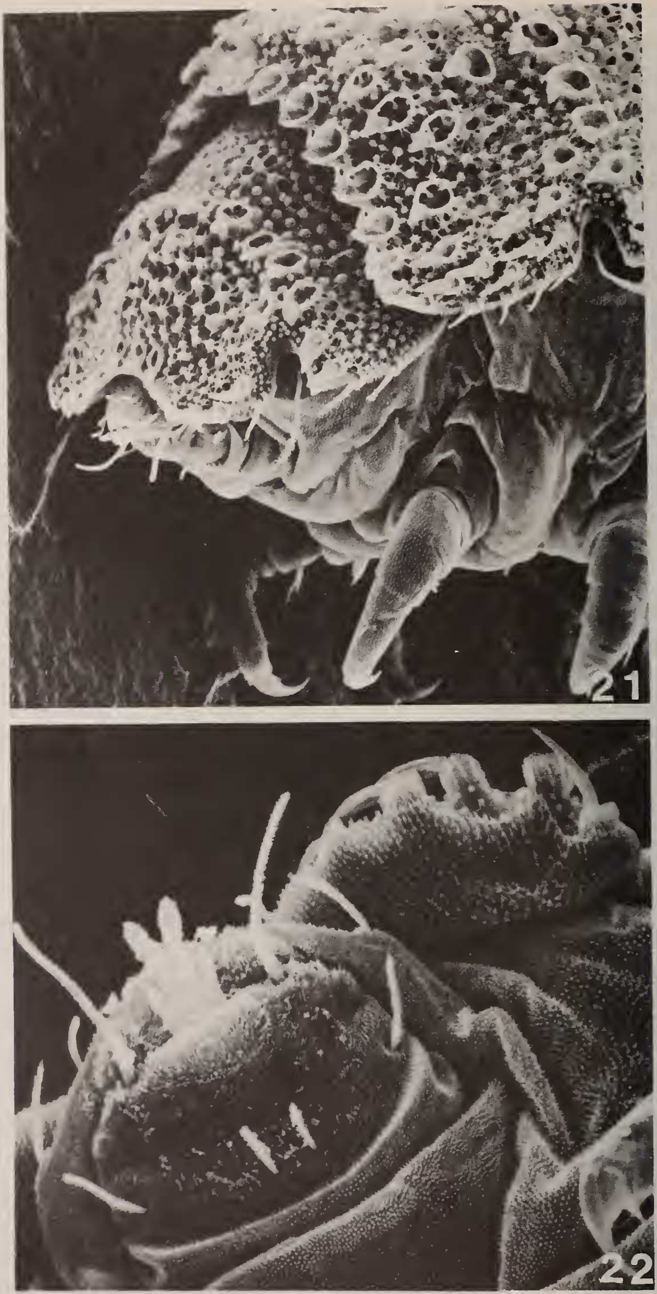


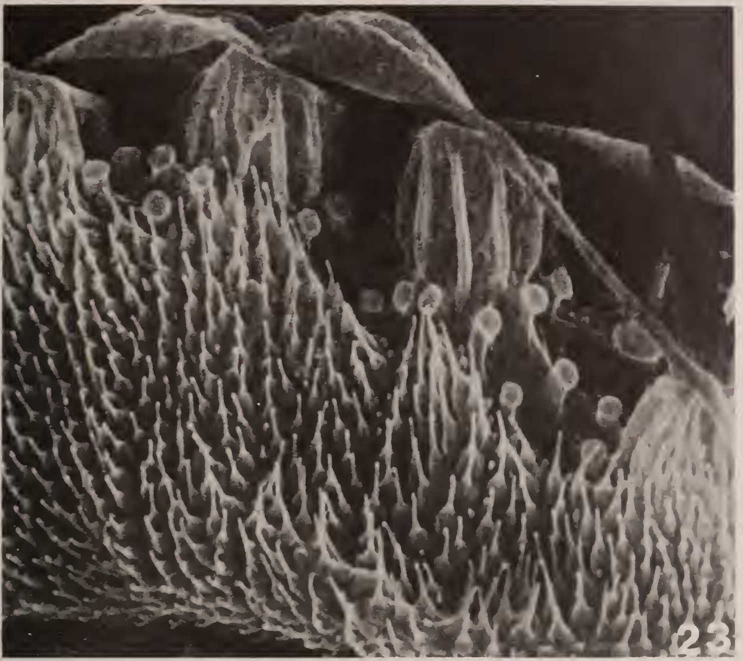
FIG. 20.

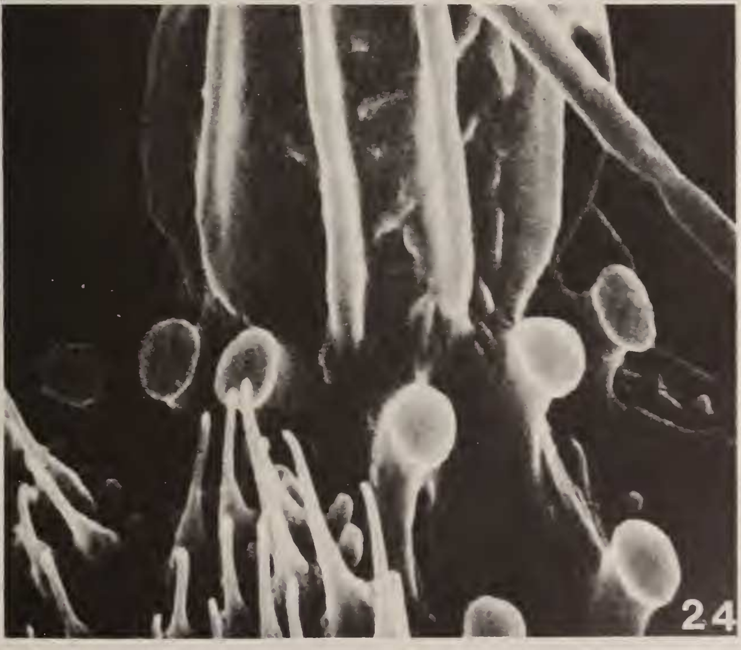
Gravieripus cordatus: Posterior view of a claw. × 5300.



FIGS. 21-22.

Gravieripus cordatus: 21. Posterior end of body with tergites V and VI, pygidium and last two pairs of legs. × 400. — 22. Ventral view of the posterior margin of tergite VI and pygidium. × 1000.





FIGS. 23-24.

Gravieripus cordatus: 23. Ventral view of tergite margin showing 3 winged and one simple straight spine. × 3500. — 24. Detail of base of a winged spine. × 12 000.

The legs are short (Fig. 15). Anterior and posterior pairs are shorter than intervening ones. The seta of trochanter (Fig. 18 left) is furcate. It has a short, cylindrical, pubescent base continuing into a long, cylindrical, pubescent branch having an apical hair about as long as the base. The secondary branch is not fully 0.5 of the length of the main branch. It is quite glabrous and pointed and has the proximal third subconically widened. The distal part of the seta on the coxa (Figs. 18 right and 19) is tooth-like, glabrous and pointed and projects from the anterior side of a large, rounded, densely pubescent base.

The main claw consists of an outer glabrous shield covering and enclosing a broad pubescent base (Fig. 20). The anterior secondary claw seems to be of the same structure, only much weaker and more pointed. There are no posterior claws, not even vestiges of them.

Pygidium

In the studied specimens the posterior part of the pygidium is not suitable to a close study. However two details are worth noting. Firstly that the styli of the pygidial tergum have the extreme shortness and the similarity to drawing-pins earlier described. They are at the posterior margin of the tergum on each side of the anal plate (Fig. 22). This character easily distinguishes *G. cordatus* from *Trachypauropus glomerioides* Tömösvary. Secondly the bases of the posteromarginal setae of the tergite VI are provided with vertical lamellae not earlier identified. These lamellae are also on the bases of the setae of the lateral margins of the tergites (Figs. 23 and 24).

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